In Situ Sediment Treatment: State of the Practice

Paul Doody and Clay Patmont, Anchor QEA, LLC

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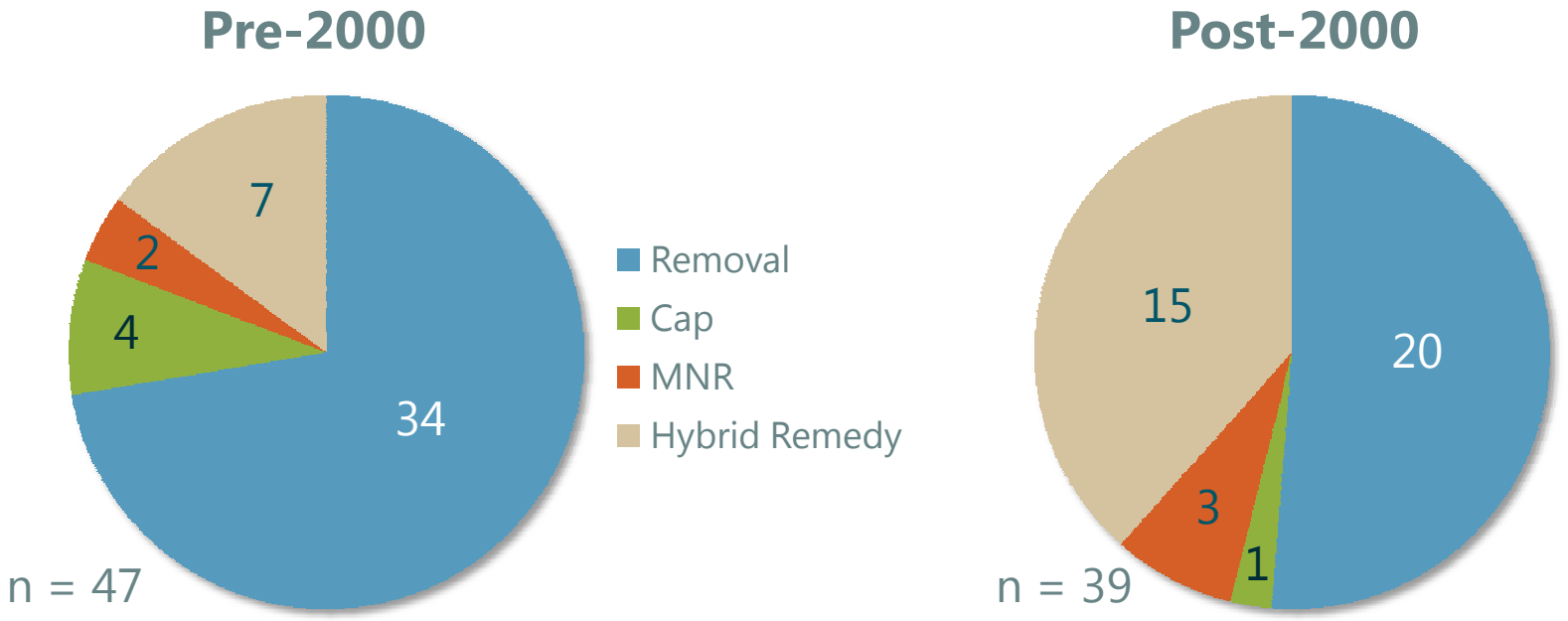
Overview

- Contaminated sediment background
- In situ treatment definitions
- In situ treatment technologies
  - Developed technologies
  - Emerging technologies
- Summary

Contaminated Sediment Cleanup

- Federal and state regulatory programs with common elements
  - Investigation of potential risks
  - Cleanup alternative evaluation
  - Implementation and monitoring
- More than 30 years of remedy implementation
  - Limited toolbox
  - Removal/dredging predominant remedy
- Adaptation for lessons learned are slow to develop
- Advancements in technology are market driven

Selected Remedial Approach



Source: Doody, Penniman, and Gehl (2011)

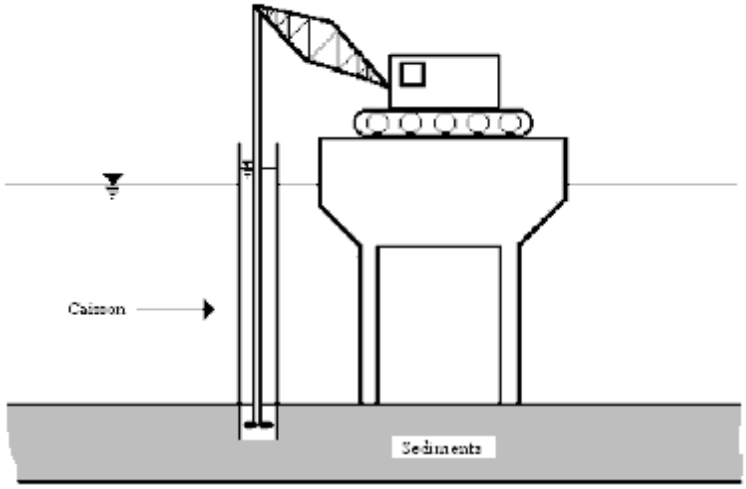
- Dredging continues to be predominant sediment remedial technology
- Hybrid remedies are becoming more prominent
- In situ treatment quickly developing and becoming more accepted

In Situ Sediment Treatment – Defined

- Active treatment
  - Direct application of amendment to sediment
  - Amendment facilitates treatment of contaminants
  - Mixing can be mechanical or biological
- Passive treatment
  - Amendment applied in cover material over sediment
  - Amendment treats porewater flux through cover
  - Commonly applied with capping remedies
- Terminology use varies
- Presentation focus on active treatment

In Situ Sediment Treatment Technologies

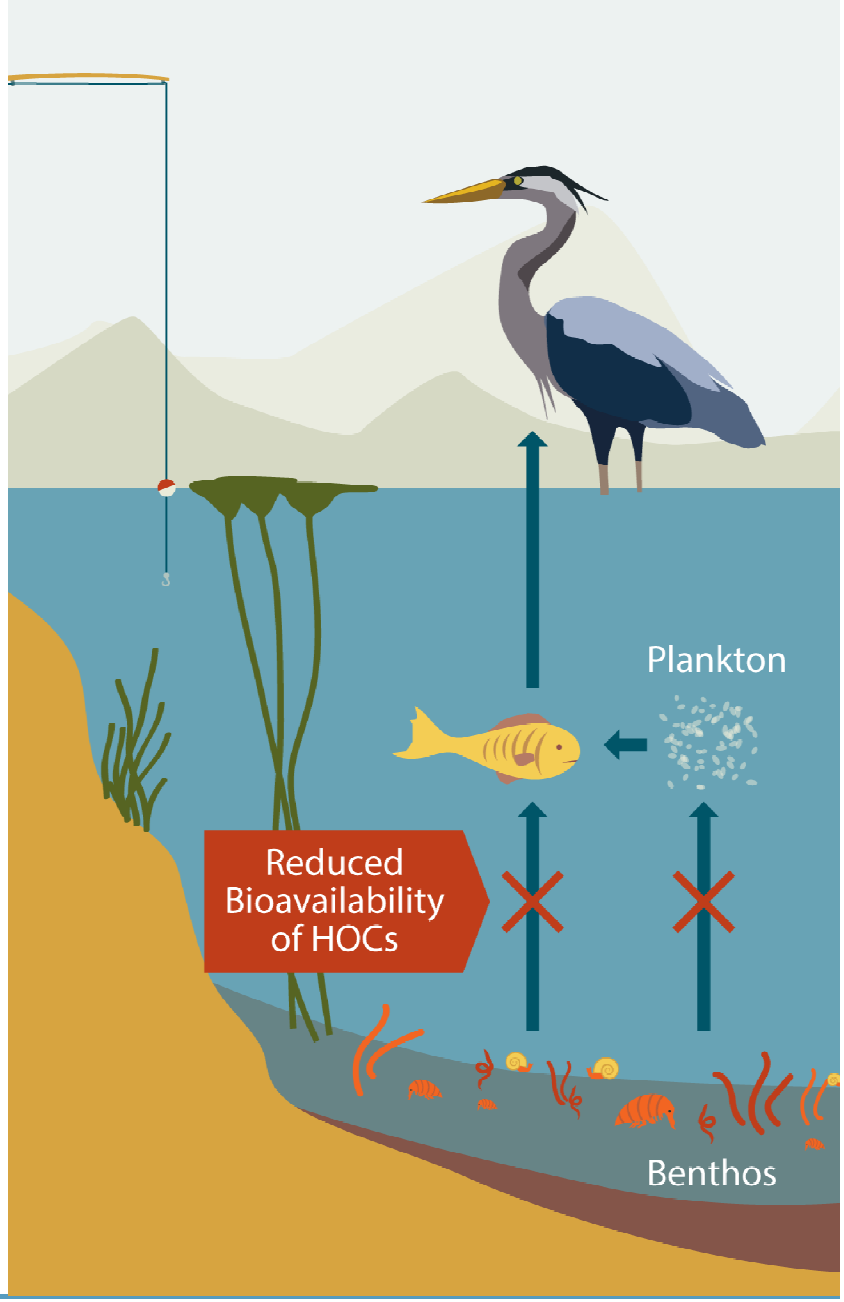
- Treatment approaches
  - Biological, chemical, physical
- Combinations
- Keys to success
  - Proper amendment selection
  - Delivery method
  - Recognize limitations
- Evolving technology
  - Activated carbon developed full scale
  - Solidification/stabilization in Gowanus Canal ROD
  - Others emerging (bioaugmentation, polymer spikes, etc.)



Source: Clu-in.org

Carbon Amendments

- Reduce bioavailability of hydrophobic organic compounds (HOCs) in resident organisms
- Reduced flux of HOCs into water column and uptake in food web
- Avoid toxicity to resident organisms



In Situ Treatment with Carbon Amendments

- Laboratory studies (2000 to present)
  - Mixing activated carbon or biochar amendments with sediments reduces the bioavailability of PCBs, PAHs, DDx, dioxins/furans, chlorinated benzenes, TBT, and methylmercury
  - Bioavailability reductions improve over time
- Field pilot studies and full-scale applications (2004 to present)
  - More than 25 field studies are now either completed or underway in a wide range of environments using a range of different application methods
  - Results continue to show success

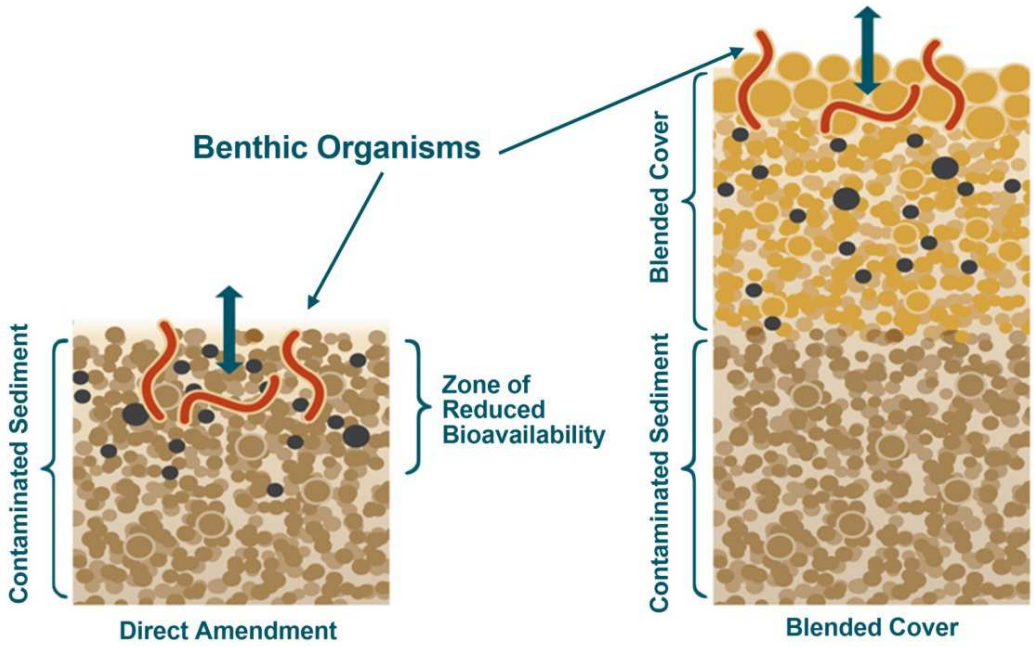
Field Pilot Study and Full-Scale Carbon Amendment Applications

United States

Europe

Carbon Application Methods

- Direct amendment
  - Thin layer (<1 cm) of amendment applied directly to surface soil/sediment, with or without initial mixing
- Blended cover
  - More uniform pre-mixing of amendment with 5 to 15 cm of clean sand applied to surface soil/ sediment

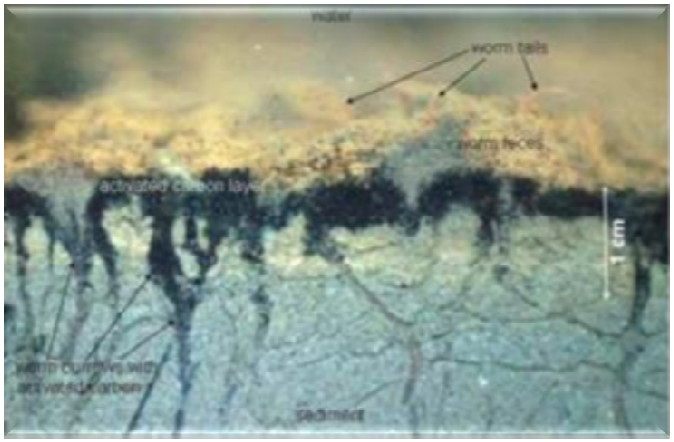


Binder and Weighting Agent Amendments

- Can improve settling of activated carbon through the water column
- Over time, the amendments break down, allowing activated carbon to mix into the biologically active zone via bioturbation

Sedimite

Bioturbation of Activated Carbon



AquaGate+PAC/BioBlok

Source: Menzie and Ghosh 2011

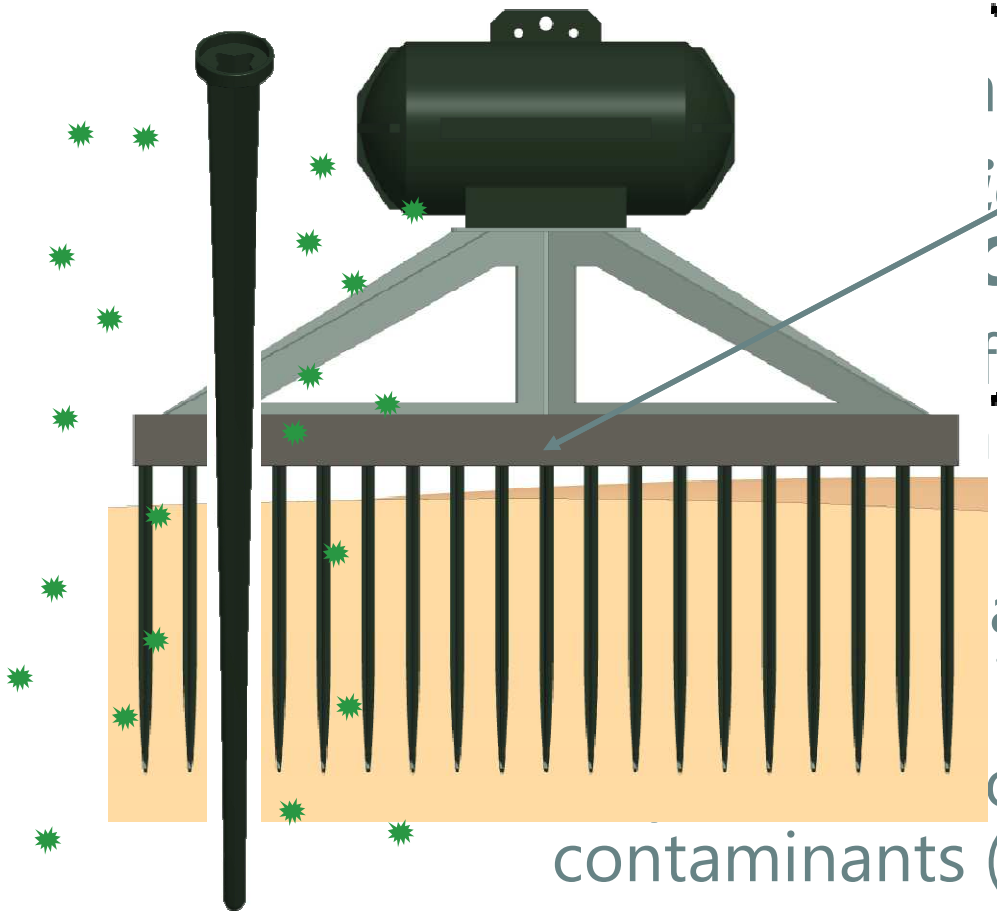
Bioaugmentation

- Adding bacteria to activated carbon to facilitate biodegradation of organics
- University of Maryland currently studying
- Laboratory scale studies of Sedimite amended with bacteria for PCB biodegradation – 70-80% reductions observed
- Pilot study application underway – preliminary results 24-36% reduction in 140 days

In Situ Solidification/Stabilization (ISS)

- ISS employed upland for many years
- SS commonly used ex situ for dredged sediment
- Primary environmental purpose of ISS
  - Reduce contaminant leachability
  - Reduce NAPL mobility
- EPRI pilot test in 2014
  - Projected costs $200-300/cy
- Gowanus ROD specified ISS
  - Pilot study during design

Absorbent Polymer Spikes



- **Emplacement Mechanism**
- **Perforated Baseplate**
- **Absorbent Polymer Spike**

de of H

or increases HDPE's

CBs by 2500%

from aqueous

nd are absorbed into

ased on contaminant

iment compaction

or other hydrophobic

contaminants (PAHs, dioxins, etc.)

Summary

- Contaminated sediment remediation toolbox is limited
- Dredging is predominant remedy choice
- In situ treatment evolving quickly, offering
  - Lower impact during remedy
  - Contaminant destruction, removal, containment
  - Lower costs
- Stay tuned!

Sources

- Use of Amendments for In Situ Remediation at Superfund Sediment Sites, OSWER Directive 9200.2-128FS April 2013
- In-Situ Solidification of Contaminated Sediments, A Technology Demonstration Project, EPRI, May 2014
- In Situ Sediment Treatment Using Activated Carbon: A Demonstrated Sediment Cleanup Technology, Patmont et al., SETAC 2014
- Remedy Selection for Contaminated Sediments, ITRC 2014

Contact Information

Paul Doody, P.E.

Anchor QEA, LLC

pdoody@anchorqea.com

(315) 409-5643

Questions/Discussion